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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/807,190	03/24/2004	Takeshi Yamamoto	57810-091	3715

7590 10/15/2009  
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600 13th Street, N.W.  
Washington, DC 20005-3096

EXAMINER
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TRINH, THANH TRUC

ART UNIT	PAPER NUMBER
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1795

MAIL DATE	DELIVERY MODE
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10/15/2009

PAPER

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

<b>Office Action Summary</b>	<b>Application No.</b> 10/807,190	<b>Applicant(s)</b> YAMAMOTO ET AL.	
	<b>Examiner</b> THANH-TRUC TRINH	<b>Art Unit</b> 1795	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 09 September 2009.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1,3,4,6,9-13,15,16 and 20-22 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1,3,4,6, 9-13,15,16 and 20-22 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)          | 4) <input type="checkbox"/> Interview Summary (PTO-413)           |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____                                      |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)          | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____  | 6) <input type="checkbox"/> Other: _____                          |

## **DETAILED ACTION**

### ***Continued Examination Under 37 CFR 1.114***

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 9/9/2009 has been entered.

### ***Claim Rejections - 35 USC § 103***

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various

claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 1, 3-4, 6, 9-11, 13 and 15-16, 20-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakata et al. (US 2001/0008295) in view of Kloppel et al. (US 20030170449), Kataoka et al. (US Patent 6133522), and Yamazaki (US patent 4746962), and further in view of Minoru (JP 2002-305212, see machine translation)

Regarding claims 1, 6, 9-11, 13, and 20- 21, as seen in Figures 1-2, Sakata et al. teaches a photovoltaic device comprising a photovoltaic element comprising a first conductivity type of single crystalline silicon semiconductor layer (e.g. 1 as seen in Figures 1-2); a substantially intrinsic non-single-crystalline semiconductor layer (or i-type a-Si layer 2 in Figure 1, 2 and 7 in Figure 2) formed on the first conductivity semiconductor layer; a transparent conductive oxide film (transparent electrode 5 made of ITO, or SnO<sub>2</sub> added In<sub>2</sub>O<sub>3</sub> in Figure 1, 5 and 10 in Figure 2 - See paragraphs 0036, 0062), and a collector electrode of Ag (See paragraph 0036). As seen in Figures 1-2, Sakata et al. teaches a surface of the crystalline semiconductor layer (1) is textured so that irregularities of the crystalline semiconductor is higher than the thickness of the transparent conductive oxide film (5) of 600-1500 Angstroms (or 60 nm - 150 nm - See paragraph 0036). Therefore it would have been obvious to have the irregularities of the crystalline semiconductor layer higher than the height of the irregularities on the surface of the transparent conductive oxide film.

The differences between Sakata et al. and the instant claims are the requirements of the transparent conductive oxide (ITO) film having an arithmetic mean deviation of the profile (or mean surface roughness) of not more than about 2 nm and the content of Sn in the transparent conductive oxide is not more than 2 percent by weight; a paste electrode formed on the transparent oxide film, wherein the paste electrode contains at least 60 percent by weight and not more than 80 percent by weight of epoxy resin; and an electric wire connected to the paste electrode by solder.

Kataoka et al. teaches a collector electrode (505) formed on the transparent conductive oxide of ITO (504), wherein the silver collector electrode in a form of paste electrode of silver and a resin material (epoxy). (See col. 9 lines 10-29). Kataoka et al. also teaches a copper tab or a tin foil (506a) attaching to the paste electrode 505 by solder. (See col. 9 lines 30-37 or col. 14 lines 37-47). The copper tab or tin foil is corresponding to the instant electric wire.

Minoru teaches a silver conductive paste containing about 60-80 wt% by weight of epoxy resin (see weight ratio of epoxy to urethane is between 10:2 to 5-10:5 in paragraph 0011 and claim 2) in the blending of epoxy and urethane resin. (See Minoru, paragraph 0011 and claim 2).

Yamazaki teaches a content of SnO<sub>2</sub> (tin oxide) in a transparent conductive oxide electrode of a solar cell is about 1-10 wt% (See col. 6 lines 21-24, or col. 9 line 33-34), or the Sn (e.g. tin) content is about 0.788-7.88 wt%.

Kloppel et al. teaches the transparent conductive oxide film of ITO having an arithmetic mean deviation of the profile (or surface roughness) of less than 1 nm. (See paragraph [0013]). While not explicitly disclosed, “the contact angle of water on the surface of the ITO film is at

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least about 40° and not more than about 74° is an inherent property when the arithmetic mean deviation of the profile (Ra) of the ITO film is in the range of at least 0.5 nm to not more than about 2 nm (see Applicant's specification, page 35 line 23 – Page 36 line 8 and Figure 8). As the surface roughness of transparent conductive oxide film (ITO) in the range of less than 1 nm and, the Examiner considers that the contact angle of water with respect to the surface of the transparent conductive oxide film is at least about 40° and not more than about 74°.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify to device of Sakata et al. by having the paste electrode of silver and epoxy resin and the electric wire connected to the paste electrode by solder as taught by Kataoka et al. with the silver conductive paste containing 60-80 wt% of epoxy in the mixture of epoxy and urethane as taught by Minoru, and the surface roughness of ITO less than 1 nm (or a contact angle of at least about 40° and not more than about 74° with respect to water) as taught by Kloppel et al; because Kataoka et al. teaches the electric wire such as copper tab 506a is used as an output terminal (See col. 9 lines 30-37 of Kataoka et al.), the silver conductive paste is suitable for collector electrode and equivalent to silver collector electrode (See col. 9 lines 10-29 of Kataoka et al.), wherein the silver conductive paste containing 60-80wt% epoxy would have low stress nature and heat-resistant reliability as taught by Minoru (See paragraph 0024 of Minoru); and because Kloppel et al. teaches it would avoid spikes by having the roughness of the ITO less than 1 nm, thereby enhancing conductivity and adhesion. (See paragraph [0005]-[0006]). In addition, it would have been obvious to one skilled in the art to select a range of less than 2 wt% of Sn in the transparent conductive oxide film ITO in the broader range of 0.788-7.88wt% disclosed by Yamazaki, because Yamazaki teaches the entire disclosed range has a

suitable utility (e.g. transparent electrode for solar cell). In such combination, the irregularities of the surface of the crystalline semiconductor layer (1), which is higher than the thickness of the transparent conductive oxide of 60-150 nm, would have been obviously higher than the irregularities of the transparent conductive oxide of height of less than 1 nm (or the surface roughness of 1nm).

Regarding claims 3 and 15, as seen in Figures 1-2, Sakata et al. teaches the photovoltaic element further comprising a second conductivity type non-single-crystalline semiconductor layer (or p-type a-Si layer 4) formed on the intrinsic non-single-crystalline (2) and the transparent conductive oxide film (5) is formed on the second conductivity type non-single-crystalline semiconductor layer (4).

Regarding claims 4 and 16, as seen in Figure 2, Sakata et al. teaches the intrinsic non-single-crystalline semiconductor layer (i-type a-Si layers 2 and 7) includes first (2) and second (7) intrinsic non-single-crystalline semiconductors formed on the upper and lower surfaces of the first conductivity type single crystalline semiconductor layer (1), respectively; a second conductivity type non-single crystalline (p-type a-Si layer 4) formed on the upper surface of the first intrinsic non-single-crystalline semiconductor layer (2); a first conductivity type fourth non-single crystalline semiconductor layer (n-type a-Si semiconductor layer 9); and the transparent conductive oxide film (5 and 10 as seen in Figure 2, paragraph 0062) including a first transparent conductive oxide film (5) formed on the upper surface of the third non-single crystalline semiconductor layer (4) and a second transparent conductive oxide film (10) formed on the lower surface of the fourth non-single crystalline semiconductor layer (9) .

5. Claims 12 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakata et al. (US 2001/0008295) in view of Kloppel et al. (US 20030170449), Kataoka et al. (US Patent 6133522), Yamazaki (US patent 4746962), and Minoru (JP 2002-305212), and further in view of Morizane et al. (US 2001/0045505)

Sakata et al. in view of Kloppel et al., Kataoka et al., Yamazaki and Minoru teaches a photovoltaic device as applied to claims 1, 3-4, 6, 9-11, 13, 15-16 and 20-21 above, wherein Kataoka et al. describes a plurality of the photovoltaic elements provided at a prescribed interval and connected in series by electric wires (copper tab and tin foil), wherein the photovoltaic element includes a first paste electrode (formed on the upper surface of photovoltaic element. (See Figures 1 and 5, col. 14 lines 37-47).

Sakata et al. in view of Kloppel et al., Kataoka et al., Yamazaki and Minoru does not teach a second paste electrode formed on the lower surface of the photovoltaic element.

Morizane et al. teaches using a second collector electrode (18). (See Figure 1 and paragraph [0052])

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Sakata et al. in view of Kloppel et al., Kataoka et al., Yamazaki and Minoru by utilizing the second collector electrode as taught by Morizane et al., because it would enable light to enter from both front and rear surfaces. (See paragraph [0051]). In such combination, it would have been obvious that the second collector electrode can be a paste collector electrode like the first collector electrode 505 of Kataoka et al. It also would have been obvious to one having ordinary skill in the art at the time the invention was made to connect the first end of the electric wire (copper tab or tin foil) to the first paste electrode of one cell and



the second end of the electric wire to the second paste electrode of another cell as taught by Morizane et al., because in this way the photovoltaic elements are connected in series as taught by Kataoka et al.

6. Claims 1, 3-4, 6, 9-11, 13 and 15-16, 20-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakata et al. (US 2001/0008295) in view of Kataoka et al. (US Patent 6133522), Yamazaki (US patent 4746962) and Kawai (JP 58-56479, see English abstract), and further in view of Minoru (JP 2002-305212, see machine translation)

Regarding claims 1, 6, 9-11, 13, and 20- 21, as seen in Figures 1-2, Sakata et al. teaches a photovoltaic device comprising a photovoltaic element comprising a first conductivity type of single crystalline silicon semiconductor layer (e.g. 1 as seen in Figures 1-2); a substantially intrinsic non-single-crystalline semiconductor layer (or i-type a-Si layer 2 in Figure 1, 2 and 7 in Figure 2) formed on the first conductivity semiconductor layer; a transparent conductive oxide film (transparent electrode 5 made of ITO, or SnO<sub>2</sub> added In<sub>2</sub>O<sub>3</sub> in Figure 1, 5 and 10 in Figure 2 - See paragraphs 0036, 0062), and a collector electrode of Ag (See paragraph 0036). As seen in Figures 1-2, Sakata et al. teaches a surface of the crystalline semiconductor layer (1) is textured so that irregularities of the crystalline semiconductor is higher than the thickness of the transparent conductive oxide film (5) of 600-1500 Angstroms (or 60 nm - 150 nm - See paragraph 0036). Therefore it would have been obvious to have the irregularities of the crystalline semiconductor layer higher than the height of the irregularities on the surface of the transparent conductive oxide film.

The differences between Sakata et al. and the instant claims are the requirements of the transparent conductive oxide (ITO) film having an arithmetic mean deviation of the profile (or mean surface roughness) of not more than about 2 nm and the content of Sn in the transparent conductive oxide is not more than 2 percent by weight; a paste electrode formed on the transparent oxide film, wherein the paste electrode contains at least 60 percent by weight and not more than 80 percent by weight of epoxy resin; and an electric wire connected to the paste electrode by solder.

Kataoka et al. teaches a collector electrode (505) formed on the transparent conductive oxide of ITO (504), wherein the silver collector electrode in a form of paste electrode of silver and a resin material (epoxy). (See col. 9 lines 10-29). Kataoka et al. also teaches a copper tab or a tin foil (506a) attaching to the paste electrode 505 by solder. (See col. 9 lines 30-37 or col. 14 lines 37-47). The copper tab or tin foil is corresponding to instant electric wire.

Minoru teaches a silver conductive paste containing about 60-80 wt% by weight of epoxy resin (see weight ratio of epoxy to urethane is between 10:2 to 5-10:5 in paragraph 0011 and claim 2) in the blending of epoxy and urethane resin.

Yamazaki teaches a content of  $\text{SnO}_2$  (tin oxide) in a transparent conductive oxide electrode of a solar cell is about 1-10 wt% (See col. 6 lines 21-24, or col. 9 line 33-34), or the Sn (e.g. tin) content is about 0.788-7.88 wt%.

Kawai teaches the ITO can be polished to have a smooth surface roughness about 1nm (See English abstract, figures 7 and 8). While not explicitly disclosed, “the contact angle of water on the surface of the ITO film is at least about 40° and not more than about 74°” is an inherent

property of the material when the arithmetic mean deviation of the profile (Ra) of the ITO film is in the range of at least 0.5 nm to not more than about 2 nm (see Applicant's specification, page 35 line 23 – Page 36 line 8 and Figure 8). As the surface roughness of transparent conductive oxide film (ITO) in the range of less than 1 nm and, the Examiner considers that the contact angle of water with respect to the surface of the transparent conductive oxide film is at least about 40° and not more than about 74°.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify to device of Sakata et al. by having the paste electrode of silver and epoxy resin and the electric wire connected to the paste electrode by solder as taught by Kataoka et al. with the silver conductive paste containing 60-80 wt% of epoxy in the mixture of epoxy and urethane as taught by Minoru, and polishing ITO to have a surface roughness of less than 1 nm (or a contact angle of at least about 40° and not more than about 74° with respect to water) as taught by Kawai; because Kataoka et al. teaches the electric wire such as copper tab 506a is used as an output terminal (See col. 9 lines 30-37 of Kataoka et al.), the silver conductive paste is suitable for collector electrode and equivalent to silver collector electrode (See col. 9 lines 10-29 of Kataoka et al.), wherein the silver conductive paste containing 60-80wt% epoxy would have low stress nature and heat-resistant reliability as taught by Minoru (See paragraph 0024 of Minoru); and because Kawai teaches it would increase the efficiency of the solar battery (see abstract of Kawai). In addition, it would have been obvious to one skilled in the art to select a range of less than 2 wt% of Sn in the transparent conductive oxide film ITO in the broader range of 0.788-7.88 wt% disclosed by Yamazaki, because Yamazaki teaches the entire disclosed range has a suitable utility (e.g. transparent electrode for solar cell). In such combination, the

irregularities of the surface of the crystalline semiconductor layer (1), which is higher than the thickness of the transparent conductive oxide of 60-150 nm, would have been obviously higher than the irregularities of the transparent conductive oxide of height of less than 1 nm (or the surface roughness of 1nm).

Regarding claims 3 and 15, as seen in Figures 1-2, Sakata et al. teaches the photovoltaic element further comprising a second conductivity type non-single-crystalline semiconductor layer (or p-type a-Si layer 4) formed on the intrinsic non-single-crystalline (2) and the transparent conductive oxide film (5) is formed on the second conductivity type non-single-crystalline semiconductor layer (4).

Regarding claims 4 and 16, as seen in Figure 2, Sakata et al. teaches the intrinsic non-single-crystalline semiconductor layer (i-type a-Si layers 2 and 7) includes first (2) and second (7) intrinsic non-single-crystalline semiconductors formed on the upper and lower surfaces of the first conductivity type single crystalline semiconductor layer (1), respectively; a second conductivity type non-single crystalline (p-type a-Si layer 4) formed on the upper surface of the first intrinsic non-single-crystalline semiconductor layer (2); a first conductivity type fourth non-single crystalline semiconductor layer (n-type a-Si semiconductor layer 9); and the transparent conductive oxide film (5 and 10 as seen in Figure 2, paragraph 0062) including a first transparent conductive oxide film (5) formed on the upper surface of the third non-single crystalline semiconductor layer (4) and a second transparent conductive oxide film (10) formed on the lower surface of the fourth non-single crystalline semiconductor layer (9) .

7. Claims 12 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakata et al. (US 2001/0008295) in view of Kataoka et al. (US Patent 6133522), Yamazaki (US patent 4746962) and Kawai (JP 58-56479), and Minoru (JP 2002-305212), and further in view of Morizane et al. (US 2001/0045505)

Sakata et al. in view of Kawai, Kataoka et al., Yamazaki and Minoru teaches a photovoltaic device as applied to claims 1, 3-4, 6, 9-11, 13, 15-16 and 20-21 above, wherein Kataoka et al. describes a plurality of the photovoltaic elements provided at a prescribed interval and connected in series by electric wires (copper tab and tin foil), wherein the photovoltaic element includes a first paste electrode (formed on the upper surface of photovoltaic element. (See Figures 1 and 5, col. 14 lines 37-47).

Sakata et al. in view of Kawai, Kataoka et al., Yamazaki and Minoru does not teach a second paste electrode formed on the lower surface of the photovoltaic element.

Morizane et al. teaches using a second collector electrode (18). (See Figure 1 and paragraph [0052])

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Sakata et al. in view of Kawai, Kataoka et al., Yamazaki and Minoru by utilizing the second collector electrode as taught by Morizane et al., because it would enable light to enter from both front and rear surfaces. (See paragraph [0051]). In such combination, it would have been obvious that the second collector electrode can be a paste collector electrode like the first collector electrode 505 of Kataoka et al. It also would have been obvious to one having ordinary skill in the art at the time the invention was made to connect the first end of the electric wire (copper tab or tin foil) to the first paste electrode of one cell and

the second end of the electric wire to the second paste electrode of another cell as taught by Morizane et al., because in this way the photovoltaic elements are connected in series as taught by Kataoka et al.

8. Claims 1, 3-4, 6, 9-11, 13 and 15-16, 20-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakata et al. (US 2001/0008295) in view of Huang (US 2004/0087252), Kataoka et al. (US Patent 6133522), and Yamazaki (US patent 4746962), and further in view of Minoru (JP 2002-305212, see machine translation)

Regarding claims 1, 6, 9-11, 13, and 20- 21, as seen in Figures 1-2, Sakata et al. teaches a photovoltaic device comprising a photovoltaic element comprising a first conductivity type of single crystalline silicon semiconductor layer (e.g. 1 as seen in Figures 1-2); a substantially intrinsic non-single-crystalline semiconductor layer (or i-type a-Si layer 2 in Figure 1, 2 and 7 in Figure 2) formed on the first conductivity semiconductor layer; a transparent conductive oxide film (transparent electrode 5 made of ITO, or SnO<sub>2</sub> added In<sub>2</sub>O<sub>3</sub> in Figure 1, 5 and 10 in Figure 2 - See paragraphs 0036, 0062), and a collector electrode of Ag (See paragraph 0036). As seen in Figures 1-2, Sakata et al. teaches a surface of the crystalline semiconductor layer (1) is textured so that irregularities of the crystalline semiconductor is higher than the thickness of the transparent conductive oxide film (5) of 600-1500 Angstroms (or 60 nm - 150 nm - See paragraph 0036). Therefore it would have been obvious to have the irregularities of the crystalline semiconductor layer higher than the height of the irregularities on the surface of the transparent conductive oxide film.

The differences between Sakata et al. and the instant claims are the requirements of the transparent conductive oxide (ITO) film having an arithmetic mean deviation of the profile (or mean surface roughness) of not more than about 2 nm and the content of Sn in the transparent conductive oxide is not more than 2 percent by weight; a paste electrode formed on the transparent oxide film, wherein the paste electrode contains at least 60 percent by weight and not more than 80 percent by weight of epoxy resin; and an electric wire connected to the paste electrode by solder.

Kataoka et al. teaches a collector electrode (505) formed on the transparent conductive oxide of ITO (504), wherein the silver collector electrode in a form of paste electrode of silver and a resin material (epoxy). (See col. 9 lines 10-29). Kataoka et al. also teaches a copper tab or a tin foil (506a) attaching to the paste electrode 505 by solder. (See col. 9 lines 30-37 or col. 14 lines 37-47). The copper tab or tin foil corresponds to instant electric wire.

Minoru teaches a silver conductive paste containing about 60-80 wt% by weight of epoxy resin (see weight ratio of epoxy to urethane is between 10:2 to 5-10:5 in paragraph 0011 and claim 2) in the blending of epoxy and urethane resin.

Yamazaki teaches a content of  $\text{SnO}_2$  (tin oxide) in a transparent conductive oxide electrode of a solar cell is about 1-10 wt% (See col. 6 lines 21-24, or col. 9 line 33-34), or the Sn (e.g. tin) content is about 0.788-7.88 wt%.

Huang teaches the transparent conductive oxide film of ITO can be polished to have a smooth surface with surface roughness of less than 1.5 nm (See paragraph 0018), and particularly 0.87 nm (see paragraph 0021). While not explicitly disclosed, "the contact angle of

water on the surface of the ITO film is at least about  $40^{\circ}$  and not more than about  $74^{\circ}$  is an inherent property of the material when the arithmetic mean deviation of the profile ( $R_a$ ) of the ITO film is in the range of at least 0.5 nm to not more than about 2 nm (See Applicant's specification, page 35 line 23 – Page 36 line 8 and Figure 8). As the surface roughness of transparent conductive oxide film (ITO) in the range of less than 1 nm and, the Examiner considers that the contact angle of water with respect to the surface of the transparent conductive oxide film is at least about  $40^{\circ}$  and not more than about  $74^{\circ}$ .

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify to device of Sakata et al. by having the paste electrode of silver and epoxy resin and the electric wire connected to the paste electrode by solder as taught by Kataoka et al. with the silver conductive paste containing 60-80 wt% of epoxy in the mixture of epoxy and urethane as taught by Minoru, and the surface roughness of ITO less than 1 nm (or a contact angle of at least about  $40^{\circ}$  and not more than about  $74^{\circ}$  with respect to water) as taught by Huang; because Kataoka et al. teaches the electric wire such as copper tab 506a is used as an output terminal (See col. 9 lines 30-37 of Kataoka et al.), the silver conductive paste is suitable for collector electrode and equivalent to silver collector electrode (See col. 9 lines 10-29 of Kataoka et al.), wherein the silver conductive paste containing 60-80wt% epoxy would have low stress nature and heat-resistant reliability as taught by Minoru (See paragraph 0024 of Minoru); and because Huang teaches it would decrease leakage current, improve efficiency and increase service life of the device (see paragraph 0018). In addition, it would have been obvious to one skilled in the art to select a range of less than 2 wt% of Sn in the transparent conductive oxide film ITO in the broader range of 0.788-7.88 wt% disclosed by Yamazaki, because Yamazaki



teaches the entire disclosed range has a suitable utility (e.g. transparent electrode for solar cell). In such combination, the irregularities of the surface of the crystalline semiconductor layer (1), which is higher than the thickness of the transparent conductive oxide of 60-150 nm, would have been obviously higher than the irregularities of the transparent conductive oxide of height of less than 1 nm (or the surface roughness of 1nm).

Regarding claims 3 and 15, as seen in Figures 1-2, Sakata et al. teaches the photovoltaic element further comprising a second conductivity type non-single-crystalline semiconductor layer (or p-type a-Si layer 4) formed on the intrinsic non-single-crystalline (2) and the transparent conductive oxide film (5) is formed on the second conductivity type non-single-crystalline semiconductor layer (4).

Regarding claims 4 and 16, as seen in Figure 2, Sakata et al. teaches the intrinsic non-single-crystalline semiconductor layer (i-type a-Si layers 2 and 7) includes first (2) and second (7) intrinsic non-single-crystalline semiconductors formed on the upper and lower surfaces of the first conductivity type single crystalline semiconductor layer (1), respectively; a second conductivity type non-single crystalline (p-type a-Si layer 4) formed on the upper surface of the first intrinsic non-single-crystalline semiconductor layer (2); a first conductivity type fourth non-single crystalline semiconductor layer (n-type a-Si semiconductor layer 9); and the transparent conductive oxide film (5 and 10 as seen in Figure 2, paragraph 0062) including a first transparent conductive oxide film (5) formed on the upper surface of the third non-single crystalline semiconductor layer (4) and a second transparent conductive oxide film (10) formed on the lower surface of the fourth non-single crystalline semiconductor layer (9) .

9. Claims 12 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakata et al. (US 2001/0008295) in view of Huang (US 2004/0087252), Kataoka et al. (US Patent 6133522), and Yamazaki (US patent 4746962), and Minoru (JP 2002-305212), and further in view of Morizane et al. (US Application Publication 20010045505)

Sakata et al. in view of Huang, Kataoka et al., Yamazaki and Minoru teaches a photovoltaic device as applied to claims 1, 3-4, 6, 9-11, 13, 15-16 and 20-21 above, wherein Kataoka et al. describes a plurality of the photovoltaic elements provided at a prescribed interval and connected in series by electric wires (copper tab and tin foil), wherein the photovoltaic element includes a first paste electrode (formed on the upper surface of photovoltaic element. (See Figures 1 and 5, col. 14 lines 37-47).

Sakata et al. in view of Huang, Kataoka et al., Yamazaki and Minoru does not teach a second paste electrode formed on the lower surface of the photovoltaic element.

Morizane et al. teaches using a second collector electrode (18). (See Figure 1 and paragraph [0052])

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Sakata et al. in view of Huang, Kataoka et al., Yamazaki and Minoru by utilizing the second collector electrode as taught by Morizane et al., because it would enable light to enter from both front and rear surfaces. (See paragraph [0051]). In such combination, it would have been obvious that the second collector electrode can be a paste collector electrode like the first collector electrode 505 of Kataoka et al. It also would have been obvious to one having ordinary skill in the art at the time the invention was made to connect the first end of the electric wire (copper tab or tin foil) to the first paste electrode of one cell and

the second end of the electric wire to the second paste electrode of another cell as taught by Morizane et al., because in this way the photovoltaic elements are connected in series as taught by Kataoka et al.

### ***Response to Arguments***

10. Applicant's arguments filed on September 9, 2009 have been fully considered but they are not persuasive.

11. Applicant's argument about the content of Sn in the transparent conductive oxide with respect to claims 1, 3-4, 6, 9-13, 15-16 and 20-22 have been considered but are moot in view of the new ground(s) of rejection.

12. Applicant argues that none of the references teaches the content of Sn in the transparent conductive oxide (e.g. ITO) is not more than 2 percent by weight. However, the Examiner respectfully disagrees. Yamazaki teaches the content of tin oxide (e.g.  $\text{SnO}_2$ ) in the transparent electrode ITO (e.g. indium tin oxide or  $\text{SnO}_2$  added  $\text{In}_2\text{O}_3$ ) is 1-10 wt% (See col. 6 lines 21-24, or col. 9 line 33-34 of Yamazaki). The content of Sn is found to be from 0.788 to 7.88wt%.

13. Applicant also argues that the conductive paste of Minoru is used as an adhesive for bonding a semiconductor chip to a substrate and that one skilled in the art would not be motivated to apply the composition of Minoru's paste to the composition of the paste electrode used for bonding the transparent conductive oxide film which is not a semiconductor chip. However, Applicant's argument is not deemed to be persuasive. First of all, Kataoka et al. teaches a conductive paste of silver and a resin material such as epoxy (see col. 9 lines 10-29 of Kataoka et al.) is bonded to the transparent conductive film such as ITO, while Minoru teaches a conductive paste of silver and a resin material such as epoxy and urethane having claimed

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composition (see paragraph 0011 and claim 2 of Minoru). It would have been obvious to use the conductive paste of Minoru in place of the conductive paste of Kataoka et al., because Minoru teaches such silver conductive paste have a low stress nature and a heat resistant reliability (See paragraph 0024 of Minoru). Both Kataoka et al. and Minoru are concerned with silver conductive paste (e.g. silver with a resin material), one would have a reasonable expectation of success from the combination.

### *Conclusion*

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to THANH-TRUC TRINH whose telephone number is (571)272-6594. The examiner can normally be reached on 8:30 am - 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Basia Ridley can be reached on 571-272-1453. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

TT  
10/06/2009

/Basia Ridley/  
Supervisory Patent Examiner, Art Unit 1795